Seismic Evaluation of Vertically Irregular Building with and without Floating Column

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Abstract - *Floating columns have become inevitable features in modern construction in order to accommodate parking and reception lobbies in first story. In the present study a framed model having floating column at different positions of a G+25 story irregular building is considered. 21m width of building is considered with 6 bays of 3.5m each along X direction and along Y direction. Irregular structures are analyzed for both zone V and zone III. Seismic evaluation for a reinforced concrete building is carried out using nonlinear analysis method. Results are compared in the form of story displacements and story drifts with & without floating columns. Zone wise results are compared using tables & graph to find out the most optimized solution. ETABS been utilized for analyzing the building structure.*

Key Words: Floating column, irregular building, vertical irregularity, ETABS.

1. INTRODUCTION

Columns which rest on beam but don't transfer the load directly to the foundation are termed as floating columns or hanging columns. The beams in turn transfer the load to other columns below it. This is widely used in high storied building which is used for both commercial and residential purpose. Floating columns are to be designed as a normal compression member. While designing transfer beam, it is designed as beam carrying all that load of column as a single point load Floating column is supported by high shear capacity beams or deep beams. At some places we can't avoid floating columns. Hence, it is wise to revise code provisions for deep beams.

1.1 Objectives

My research project aims at doing seismic evaluation for a reinforced concrete building using nonlinear analysis method. The main objectives of the proposed work are:

- To study the behavior of vertically irregular building under earthquake excitations.
- To study the effects of story displacement and story drift with floating columns located at different positions of a G+25 irregular multi-storey building in different zones.

2. DESCRIPTION OF THE MODEL

In the present study a framed model having floating column at different positions of a G+25 story irregular building is considered.21m width of building is considered with 6 bays of 3.5m each along X direction and along Y direction. Earth quake analysis is carried out considering the 3D frames as per IS 1893:2016. The Typical plan and elevation of the models considered for the study is shown. The details of the building data are same as shown in Table 1. Irregular structures are analyzed for both Zone V and Zone III. Seismic evaluation for a reinforced concrete building is carried out using nonlinear analysis method. Analysis is carried out to determine the effects of story displacement and story drift with floating columns located at different positions of a G+25 irregular multi-story building in different zones.

Five models are analysed in both zone V and zone III. All the 5 models have same plan whereas the position of floating columns are changed in each model at ground story.

MODEL 1: Normal building without floating column.

MODEL 2: Building with floating column at corners.

MODEL 3: Building with floating column at outer middle portion

MODEL4: Building with floating column located alternatively at outer four sides

MODEL 5: Building with floating column located at centre

Typical plan and elevation are shown in Fig 1 to Fig 9. There is a vertical irregularity introduced by reducing the bays in story 24 and story 25 as per Fig 4 of I S 1893-2016. Specifications are given in table 1.

Table -1: Specifications

Storey height	3m
Thickness of slab	0.15m
Column size	0.8x0.8m
Beam size	0.2x0.4m 0.2x0.6m
Soil type	Medium (II)

Floor area	441m^2
Live load	3kN/m^2
Density of RCC considered	25 kN/m^3
Height of structure	75m
Floor finish	1.5kN/m^2
Number of floors	25
Code used	IS 1893:2016
Seismic Zones	V,III
Zone factor	0.36,0.16
Importance factor	1
Response reduction factor	5(SMRF)
Material used	M30 Concrete Fe 500 steel

Model 1: Normal building without floating column

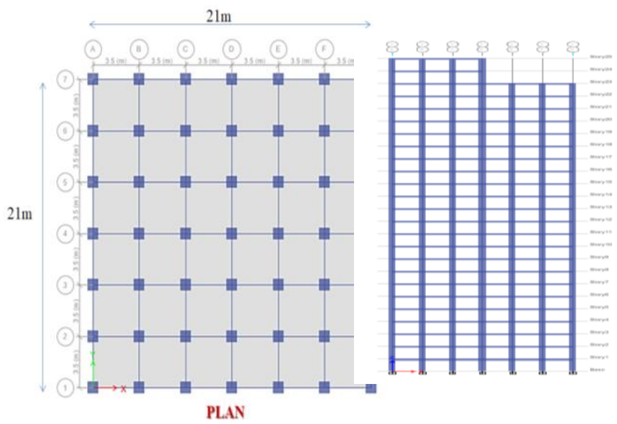

Fig -1: Typical plan and elevation of normal building without floating column

Model 2: Building with floating column at corners

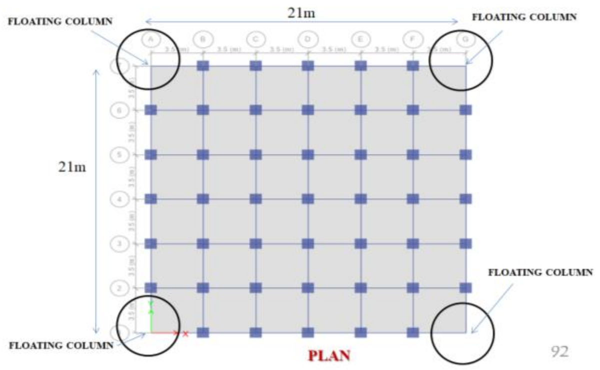

Fig -2: Typical plan of building with floating column at corners

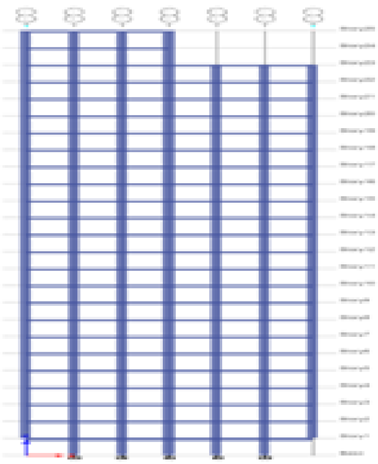

Fig -3: Elevation

Model 3: Building with floating column at outer middle portion

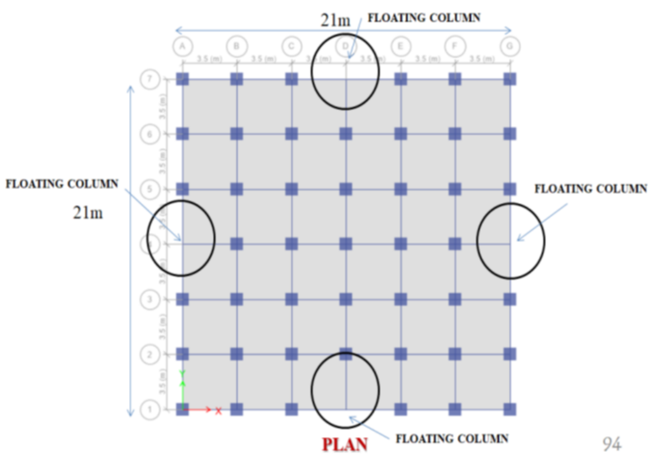

Fig -4: Typical plan of building with floating column at outer middle portion

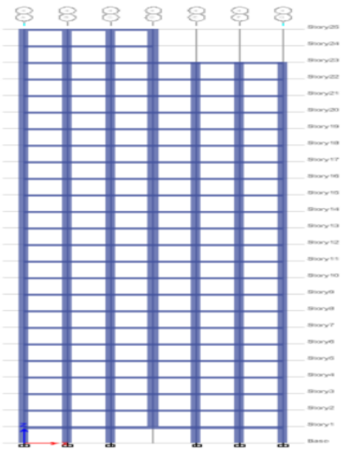

Fig -5: Elevation

Model 4: Building with floating column located alternatively at outer side

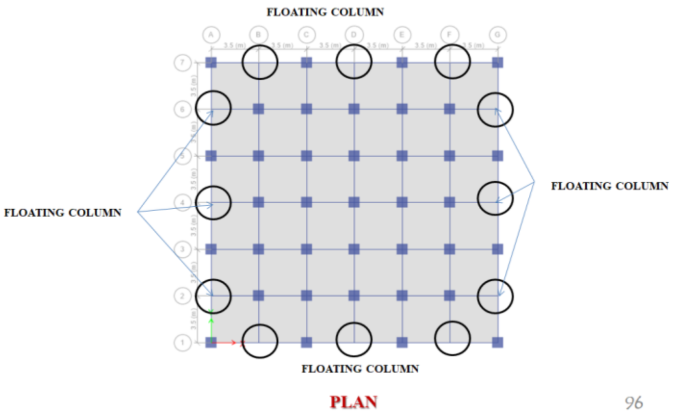

Fig -6: Typical plan of building with floating column located alternatively at outer side

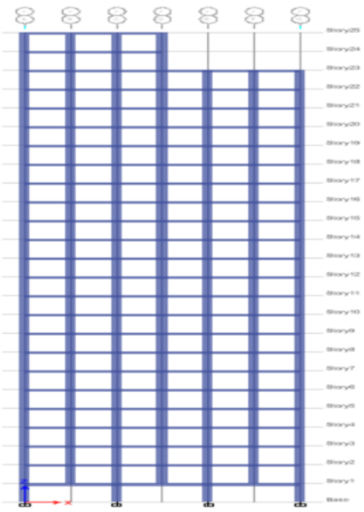

Fig -7: Elevation

Model 5: Building with floating column located at centre

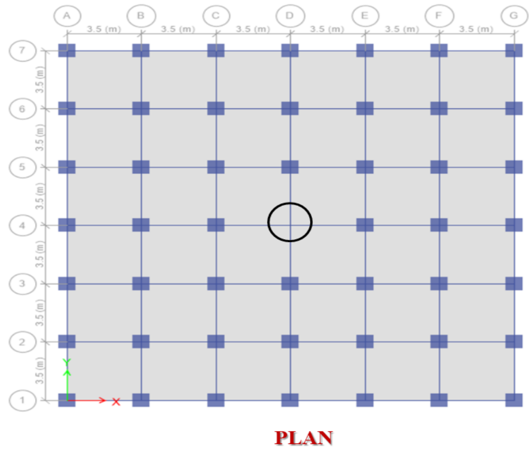

Fig -8: Typical plan of building with floating column located at centre

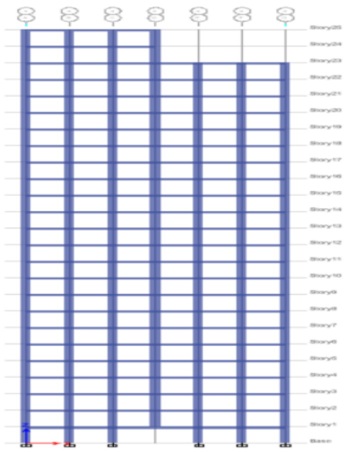

Fig -9: Elevation

Five models are prepared by varying the position of floating column at ground story. Models are prepared by placing the floating columns at outer middle portion, center, corner and alternate position. These four models have to be compared with that of normal building (model 1) without floating column and select an extreme suitable positioning of floating column without the failure of structure.

3. RESULTS AND DISCUSSION

As mentioned earlier the selected building models are analyzed. Response spectrum analysis of five building models is carried out to study the displacement and story drift. This analysis also aims to find out the performance of building in two different seismic zones i.e., zone V, zone III.

3.1 Variations of story displacement in zone V and zone III when floating columns are located at first story.

Table -2: Variations in maximum story displacement for zone v and zone III

Maximum story displacement(mm)		
POSITION OF FLOATING COLUMN	**ZONE V**	**ZONE III**
Without floating column	176.330	45.762
Floating column at outer middle	198.421	76.518
Floating column at centre	297.22	90.971
Floating column at alternate	309.04	116.53
Floating column at corner	468.427	146.828

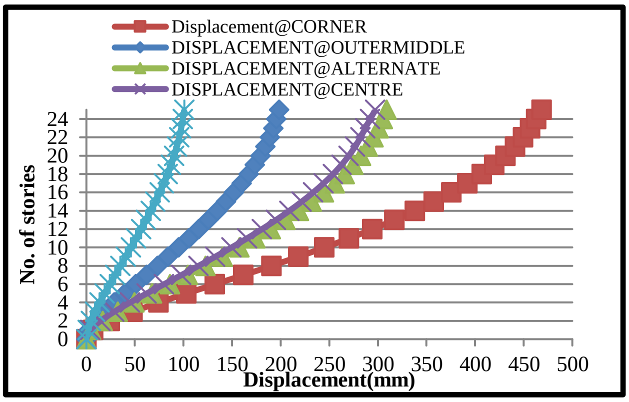

Chart -1: Variations of storey displacement in zone v

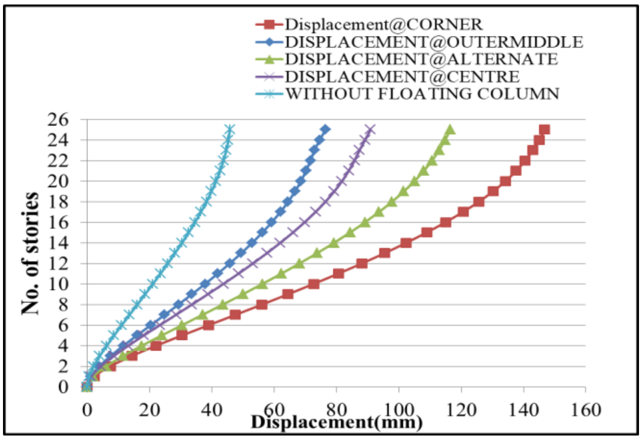

Chart -2: Variations of storey displacement in zone III

3.2 Variations of storey drifts in zone V and zone III when floating columns are located at first story.

Table – 3: Variations in storey drift for zone v and zone III

Maximum story drift		
POSITION OF FLOATING COLUMN	**ZONE V**	**ZONE III**
Without floating column	0.000587	0.000064
Floating column at outer middle	0.000895	0.000397
Floating column at centre	0.001308	0.000368
Floating column at alternate	0.00163	0.000651
Floating column at corner	0.00237	0.000834

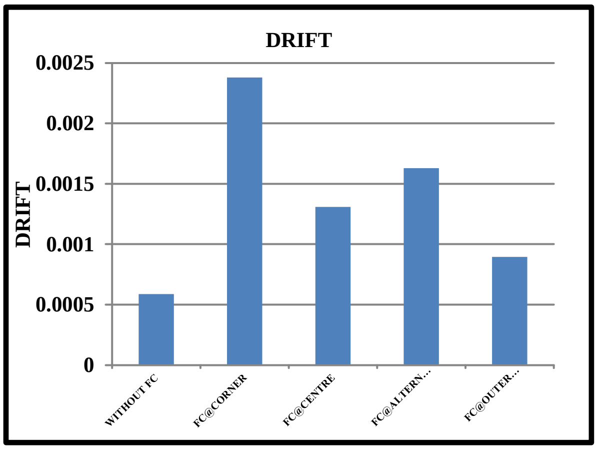

Chart -3: Variations of storey drift in zone v

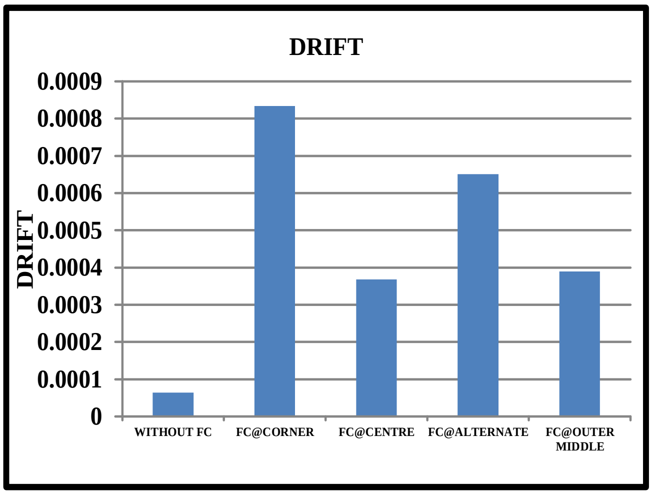

Chart -4: Variation of storey drift in zone III

In all the cases maximum displacement is obtained at top story .There is a 68% increase in displacement for models in zone v when compared to zone III. Floating columns provided at corner position have higher displacement. Floating columns provided at outer middle and centre is comparatively having low displacements.

In all the cases maximum drift is obtained at top story. There is a 64% increase in drift for models in zone v when compared to zone III. Floating columns provided at corners have higher drift. Floating columns provided at outer middle and centre are comparatively having lower drift.

From above results it can be concluded that floating columns provided at corner position is critical when compared to other models even though the parameters are within the limits.

Displacement limit: Not greater than H/500=150mm.

Drift limit: Not greater than 0.004xstory height=0.012.

Here all values are within the limit only for zone III. Hence zone v is unsafe and zone III is taken as critical zone with corner positioning of floating column. From above results it can be concluded that floating columns provided at corner position is critical when compared to other models even though the parameters are within the limits. Zone v has higher displacement and it is unsafe.

4. CONCLUSIONS

The study presented in the paper gives the zone wise evaluation of buildings with and without floating column. The following conclusions were drawn based on the investigation.

- In the case of irregular buildings higher displacement and drift are obtained at zone v when floating columns are placed at corner position when compared to zone III. Hence it is not suitable in high seismic zone (i.e, zone v) since abrupt changes are observed.
- Floating columns at irregular buildings are safe only if they are provided in zone III.There is more increase in the displacement for the irregular floating column buildings
- Floating columns provided at outer middle and centre position is comparatively having low displacements and hence they can be adopted

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